IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

Patent Application No. 10/555,729

Confirmation No. 2003

Applicant: Nie et al.

Filed: December 21, 2006

TC/AU: 1641

Examiner: Leon Yun Bon Lum

Docket No.: 239659 (Client Reference No. 0215-US)

Customer No.: 23460

APPELLANTS' APPEAL BRIEF

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Sir:

In support of the appeal from the final rejection dated May 7, 2010, Appellants now submit their Brief.

Real Party In Interest

The patent application that is the subject of this appeal is assigned to Indiana University Research & Technology Corporation, who is the real party in interest.

Related Appeals and Interferences

There are no appeals or interferences that are related to this appeal.

Status of Claims

Claims 1-197, 200-202, 208, and 209 were cancelled during prosecution of the patent application. Claims 198, 199, 203-207, and 210-224 currently are pending. Claims 216 and 217 have been withdrawn in response to a restriction requirement. Claims 198, 199, 203-207,

210-15, and 218-224 have been rejected by the Examiner. Accordingly, claims 198, 199, 203-207, 210-15, and 218-224 are the subject of this appeal.

Status of Amendments

No amendments were filed by Appellants subsequent to the final rejection dated May 7, 2010. All prior amendments have been entered by the Examiner.

Summary of Claimed Subject Matter

There are two independent claims on appeal, namely claims 198 and 206.

The invention defined by appealed claim 198 relates to a concentration-gradient quantum dot comprising an alloy of a first semiconductor and a second semiconductor, wherein the concentration of the first semiconductor gradually increases from the core of the quantum dot to the surface of the quantum dot and the concentration of the second semiconductor gradually decreases from the core of the quantum dot to the surface of the quantum dot (see specification at, e.g., paragraphs 0010 and 0039), wherein the alloy comprises CdSeTe and has a molecular formula $CdSe_{1-x}Te_x$, the alloy comprises CdSSe and has a molecular formula $CdS_{1-x}Se_x$, the alloy comprises CdSTe and has a molecular formula $CdS_{1-x}Te_x$, the alloy comprises ZnSeTe and has a molecular formula $ZnSe_{1-x}Te_x$, the alloy comprises ZnCdTe and has a molecular formula $Zn_{1-x}Cd_xTe$, the alloy comprises CdHgS and has a molecular formula $Cd_{1-x}Hg_xS$, the alloy comprises HgCdTe and has a molecular formula HgCdTe, the alloy comprises InGaAs and has a molecular formula InGaAs, the alloy comprises GaAlAs and has a molecular formula GaAlAs, or the alloy comprises InGaN and has a molecular formula InGaN, wherein x is any fraction between 0 and 1 (see specification at, e.g., paragraphs 0045-0047 and page 55 at originally filed claims 107 and 108), and wherein the concentration-gradient quantum dot has a band gap energy that is non-linearly related to the molar ratio of the at least two semiconductors (see, specification at, e.g., paragraph 0054).

The invention defined by appealed claim 206 relates to a series of concentration-gradient quantum dots, wherein each quantum dot comprises an alloy of a first semiconductor and a second semiconductor, wherein, for each quantum dot, the concentration of the first semiconductor gradually increases from the core of the quantum dot to the surface of the quantum dot and the concentration of the second semiconductor gradually decreases from the

core of the quantum dot to the surface of the quantum dot, wherein the gradient by which the concentration of the first semiconductor increases and the gradient by which the concentration of the second semiconductor decreases from the core of the quantum dot to the surface of the quantum dot varies among the quantum dots of the series, wherein the size of each quantum dot is within about 5% of the size of the average-sized quantum dot (see specification at, e.g., paragraphs 0011 and 0062), wherein the alloy comprises CdSeTe and has a molecular formula $CdSe_{1-x}Te_x$, the alloy comprises CdSSe and has a molecular formula $CdS_{1-x}Se_x$, the alloy comprises CdSTe and has a molecular formula $CdS_{1-x}Te_x$, the alloy comprises ZnSeTe and has a molecular formula $ZnSe_{1-x}Te_x$, the alloy comprises ZnCdTe and has a molecular formula $Zn_{1-x}Cd_xTe$, the alloy comprises CdHgS and has a molecular formula $Cd_{1-x}Hg_xS$, the alloy comprises HgCdTe and has a molecular formula HgCdTe, the alloy comprises InGaAs and has a molecular formula InGaAs, the alloy comprises GaAlAs and has a molecular formula GaAlAs, or the alloy comprises InGaN and has a molecular formula InGaN, wherein x is any fraction between 0 and 1 (see specification at, e.g., paragraphs 0045-0047 and pages 57-58 at originally filed claims 128 and 129), wherein each quantum dot comprises the same semiconductors (see specification at, e.g., paragraph 0011 and 0062), and wherein each quantum dot of the series has a band gap energy that is non-linearly related to the molar ratio of the at least two semiconductors (see, specification at, e.g., paragraph 0054).

Grounds of Rejection to be reviewed on Appeal

A. Whether claims 198, 199, 203-207, 210-215 and 218, 220, 221, 223, and 224 are unpatentable under 35 U.S.C. § 103(a) in view of U.S. Patent 6,710,366 (Lee et al.) ("the Lee patent") in combination with U.S. Patent 6,207,392 (Weiss et al.) ("the Weiss patent").

B. Whether claims 219 and 222 are unpatentable under 35 U.S.C. § 103(a) in view of the Lee patent in combination with the Weiss patent and U.S. Patent 6,846,565 (Korgel et al.) ("the Korgel patent").

Argument

A. Obviousness Rejection of Claims 198, 199, 203-207, 210-215 and 218, 220, 221, 223, and 224

The subject matter defined by claims 198, 199, 203-207, 210-215 and 218, 220, 221, 223, and 224 allegedly is obvious in view of the Lee patent in combination with the Weiss patent.

For subject matter defined by a claim to be considered obvious, the Examiner must demonstrate that the differences between the claimed subject matter and the prior art "are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains." 35 U.S.C. § 103(a); see also *Graham v. John Deere Co.*, 383 U.S. 1, 148 U.S.P.Q. 459 (1966). The ultimate determination of whether an invention is or is not obvious is based on certain factual inquiries including: (1) the scope and content of the prior art, (2) the level of ordinary skill in the prior art, (3) the differences between the claimed invention and the prior art, and (4) objective evidence of nonobviousness. *Graham*, 383 U.S. at 17-18, 148 U.S.P.Q. at 467.

Scope and Content of the Prior Art

The Lee patent discloses quantum dots comprising a core, a shell, and a region between the core and the shell referred to as an "interface region" (see column 7, lines 16-18). The Lee patent discloses that "the interface region may be homogenous or inhomogenous and may comprise chemical characteristics that are graded between the core and shell materials such that a gradual or continuous transition is made between the core and the shell" (see column 7, lines 25-29). The Lee patent discloses methods to produce shelled quantum dots as follows:

> The fabrication of some types of shells on quantum dots can be performed using a variety of methods. Preferred methods include those described in X. Peng et al., "Epitaxial Growth of Highly Luminescent CdSe/CdS Core/Shell Nanocrystals with Photostability and Electronic Accessibility," *J. Am. Chem. Soc.* 119, 7019 (1997) and B. O. Dabbousi et al., "(CdSe)ZnS Core-Shell Quantum Dots: Synthesis and Characterization of a Size Series of Highly Luminescent Nanocrystallites," *J. Phys. Chem.* B 101, 9463 (1997), the disclosures of which are hereby incorporated by reference in their entirety.

(column 33, lines 11-21).

The Weiss patent discloses that the emission wavelength of a semiconductor nanocrystal can be selected by varying the composition of the nanocrystal alloy (see column 8, line 61, through column 9, line 11). The Weiss patent discloses an illustrative embodiment, as follows:

> [A] CdS semiconductor nanocrystal, having an emission wavelength of 400 nm, may be alloyed with a CdSe semiconductor nanocrystal, having an emission wavelength of 530 nm. When a nanocrystal is prepared using an alloy of CdS and CdSe, the wavelength of the emission from a plurality of identically sized nanocrystals *may be tuned continuously from 400 nm to 530 nm depending on the ratio of S to Se present in the nanocrystal.*

(column 8, line 64, through column 9, line 4) (emphasis added).

The Weiss patent discloses that methods to prepare nanocrystals in a core/shell configuration are described in Peng et al., *J. Am. Chem. Soc., 119 (30)*: 7019-7029 (1997) and Dabbousi et al., *J. Phys. Chem., B 101*: 9463-9475 (1997) (see column 8, lines 5-13 and column 29, lines 9-19), which are the same two references cited in the Lee patent as disclosing methods to produce shelled quantum dots.

Level of Ordinary Skill in the Art

For the sake of argument and for purposes of the present analysis, one of ordinary skill in the art can be assumed to be someone with an advanced degree in chemistry, physics, or a similar science and/or several years of experience in the relevant art.

Differences Between the Claimed Invention and the Prior Art

Claims 199, 203-205, 207, 210-215, and 218, 220, 221, 223, and 224 depend from claim 198 or claim 206, either directly or indirectly. Appealed claims 198 and 206 require, *inter alia*, a concentration-gradient quantum dot (claim 198) or a series of concentration-gradient quantum dots (claim 206), wherein the quantum dot or each quantum dot in the series comprises an alloy of a first semiconductor and a second semiconductor, wherein the concentration of the first semiconductor gradually increases from the core of the quantum dot to the surface of the quantum dot and the concentration of the second semiconductor gradually decreases from the core of the quantum dot to the surface of the quantum dot, and

wherein the concentration-gradient quantum dot has a band gap energy that is *non-linearly related to the molar ratio of the at least two semiconductors*.

The Examiner acknowledges that the Lee patent does not disclose specific ratios of semiconductor materials as claimed. The Lee patent also fails to provide any generalized method steps or any specific examples directed to a quantum dot comprising a gradual or continuous transition between the core and the shell. Furthermore, the Lee patent does not disclose any optical properties of a quantum dot comprising a gradual or continuous transition between the core and the shell.

The Weiss patent does not disclose a concentration-gradient quantum dot, much less a generalized method or specific example of preparing the same. As regards optical properties, the Weiss patent discloses that when a nanocrystal is prepared using an alloy of CdS, which has an emission wavelength of 400 nm, and CdSe, which has an emission wavelength of 530 nm, that the wavelength of the emission from a plurality of identically sized nanocrystals "may be tuned continuously from 400 nm to 530 nm depending on the ratio of S to Se present in the nanocrystal" (column 8, line 64, through column 9, line 4). The Weiss patent does not disclose a nanocrystal or quantum dot having a band gap energy that is non-linearly related to the molar ratio of the at least two semiconductors.

The Examiner alleges that because the Weiss patent discloses that tuning an alloy concentration would affect emission wavelength, routine optimization by one of ordinary skill in the art, in combination with the disclosure of the Lee patent, would have led to the invention of claims 198 and 206. However, Appellants respectfully submit that neither the Lee patent nor the Weiss patent discloses a concentration-gradient quantum dot or a series of concentration-gradient quantum dots having a band gap energy that is non-linearly related to the molar ratio of the at least two semiconductors as defined by the appealed claims.

Objective Evidence of Nonobviousness

For purposes of the analysis here, there is no need to consider any objective criteria of nonobviousness.

Consideration of Graham Factors Together

As recently stated by the Supreme Court, "*there must be some articulated reasoning* with some rational underpinning to support the legal conclusion of obviousness." *KSR Int'l v.*

Teleflex Inc., 550 U.S. 398, 418, 82 U.S.P.Q.2d 1385, 1396 (2007) (quoting *In re Kahn*, 441 F.3d 977, 988 (Fed. Cir. 2006) (emphasis added)). Here, the Examiner has failed to identify a credible reason why one of ordinary skill in the art would modify the teachings of the Lee and Weiss patents in such a way so as to provide a quantum dot or a series thereof, as recited in the appealed claims.

In particular, as discussed above and in the previously submitted Rule 132 Declaration (see Exhibit A of the Evidence Appendix attached hereto), the Lee patent fails to provide any generalized method steps or any specific examples directed to a quantum dot comprising a gradual or continuous transition between the core and the shell. As stated in the Rule 132 Declaration, there are no examples in the Lee patent directed to a quantum dot comprising a gradual or continuous transition between the core and the shell. The Lee patent also does not set forth any general methods of preparing a quantum dot comprising a gradual or continuous transition between the core and the shell, much less the specific methods that would be required to allow one of ordinary skill in the art to make such a quantum dot.

The Weiss patent does not compensate for the deficiencies of the Lee patent. In particular, the Weiss patent does not disclose a generalized method or a specific example of preparing a concentration-gradient quantum dot, as defined by the appealed claims. Therefore, neither the Lee nor Weiss patents provide *any* disclosure – enabling or otherwise – of how to prepare a concentration-gradient quantum dot. Without any teaching, pointer, or suggestion as to how to prepare the quantum dot comprising an "interface region," as disclosed by the Lee patent, one of ordinary skill in the art would not have had a reasonable expectation of success to prepare a quantum dot encompassed by the appealed claims.

The Examiner acknowledges that the present application provides more description regarding the production of concentration-gradient quantum dots than the Lee patent. However, the Examiner maintains that because the Lee patent is an issued patent, it is presumed to be enabling. Appellants respectfully point out that an important aspect of Appellants' discovery is that the concentration-gradient quantum dots can be prepared in a *single step* by controlling the ratio of semiconductors, reaction temperature, growth time, and nucleation rate (see paragraph 00148), *which method is distinct from the two-step methods known in the art at the time of the present invention to prepare core-shell nanocrystals* (see paragraph 00149). As discussed above, none of the cited references provides any generalized methods or specific examples to prepare a quantum dot comprising a gradual or continuous transition between the core and the shell. In

fact, both the Lee patent and the Weiss patent cite the same references (i.e., Peng et al., *J. Am. Chem. Soc., 119 (30)*: 7019-7029 (1997) and Dabbousi et al., *J. Phys. Chem., B 101*: 9463-9475 (1997)) as disclosing methods to prepare core-shell nanocrystals. However, as discussed in the present specification, Peng et al. and Dabbousi et al. both describe *two-step processes* which result in nanocrystals *having an abrupt boundary between the core and the shell* (see paragraph 00149).

Thus, Appellants maintain that the cited references fail to provide an enabling disclosure of how to prepare the claimed quantum dots. Therefore, one of ordinary skill in the art would not know how – nor have a reasonable expectation of success – prepare any concentration-gradient quantum dot, much less a concentration-gradient quantum dot having a band gap energy that is non-linearly related to the molar ratio of the at least two semiconductors.

Furthermore, Appellants discovered a non-trivial synthesis method, previously unknown, to provide the claimed concentration-gradient quantum dot with the required optical properties. Such non-trivial synthesis includes quantum dots that are prepared in a single step by controlling, for example, the ratio of semiconductors, reaction temperature, growth time, and nucleation rate. These parameters are neither disclosed nor appreciated by either of the cited references, such that the ordinarily skilled artisan would not have had a credible reason to modify the disclosure of the Lee and/or Weiss patent in such as way as to arrive at the claimed quantum dot or a series thereof.

Even if, *arguendo*, one of ordinary skill in the art (i) stumbled upon some unidentified method to prepare a concentration-gradient quantum dot, and (ii) was led to combine the disclosure of the Lee and Weiss patents, he or she would be expected to arrive at – at best – a concentration-gradient quantum dot having an emission spectra somewhere *in between* the emission wavelength of the two semiconductor materials depending upon the mole ratio of semiconductors present in the alloyed dot. One would be expected to arrive at such dot (again, assuming one could prepare a concentration-gradient quantum dot in the first place) because the Weiss patent (i.e., the only cited reference which describes the optical properties of alloyed semiconductors) discloses that when a nanocrystal is prepared using an alloy of CdS, which has an emission wavelength of 400 nm, and CdSe, which has an emission wavelength of 530 nm, the wavelength of the emission from a plurality of identically sized nanocrystals "may be tuned continuously from 400 nm to 530 nm depending on the ratio of S to Se present in the nanocrystal" (column 8, line 64, through column 9, line 4). Based upon the teachings of the Weiss patent, one of ordinary skill in the art would *not* have developed a

concentration-gradient quantum dot or a series of concentration-gradient quantum dots having a band gap energy that is *non-linearly related to the molar ratio of the at least two semiconductors*. The Weiss patent, in fact, teaches away from a concentration-gradient quantum dot having the claimed optical properties.

The Examiner appears to contend that the unique optical properties of the claimed quantum dots (i.e., a band gap energy that is non-linearly related to the molar ratio of the at least two semiconductors) are merely a product of combining two semiconductors (Office Action, paragraph bridging pages 9 and 10). Such contention is not true because the presently claimed invention is based, at least in part, on Apellants' surprising discovery that certain semiconductors (e.g., tellurium) are considerably more reactive than other semiconductors (e.g, selenium) towards a common semiconductor (e.g., cadmium) under rapid nucleation and growth conditions. This discovery was used to create a strategy for synthesizing two distinct types of quantum dots, specifically, quantum dots with a *gradient structure* produced under cadmium-rich conditions (see paragraph 00148), and quantum dots with a *homogenous structure* produced under cadmium-limited conditions (see paragraph 00152). It was also surprisingly discovered that an excess of one semiconductor (e.g., cadmium) relative to the total mole amounts of two other semiconductors (e.g., selenium and tellurium) led to the formation of alloyed dots with a gradient structure characterized by a band gap energy that is non-linearly related to the molar ratio of the at least two semiconductors (see paragraphs 0143 and 0152 and Figure 6). Moreover, Appellants found that the band gap energy can extend beyond the range defined by the band gap energies of the respective components.

Furthermore, Appellants respectfully point out that the appealed claims are not directed to any combination of two semiconductors, as the Examiner appears to imply, but, rather, the appealed claims require, *inter alia*, that the concentration-gradient quantum dot comprises one of several specific alloys having a specific molecular formula. As set forth at paragraph 0054 of the specification, the inventive alloyed semiconductor quantum dots have unique optical properties due to the non-linear relationship between the band gap energy and the molar ratio of the at least two semiconductors that comprise the quantum dot. As discussed above, neither the Lee patent nor the Weiss patent discloses or suggests a concentration-gradient quantum dot or a series of concentration-gradient quantum dots comprising the specific alloys recited in the appealed claims having a band gap energy that is non-linearly related to the molar ratio of the at least two semiconductors.

In view of the foregoing, the Examiner has failed to identify a credible reason why one of ordinary skill in the art would modify the optical properties of the alloyed semiconductor disclosed in the Weiss patent in the manner necessary (i.e., to achieve a band gap energy that is non-linearly related to the molar ratio of the at least two semiconductors), and then develop a concentration-gradient quantum dot having such modified optical properties based upon the disclosure of the Lee patent, in order to arrive at the present invention as defined by the appealed claims.

Considering all of the Graham factors together and without a credible reason, it is clear that the present invention would not have been obvious to one of ordinary skill in the art at the relevant time in view of the cited references. Accordingly, the obviousness rejection of appealed claims 198, 199, 203-207, 210-215 and 218, 220, 221, 223, and 224 should be withdrawn.

B. Obviousness Rejection of Claims 219 and 222

The subject matter defined by claims 219 and 222 allegedly is obvious in view of the Lee patent in combination with the Weiss patent and the Korgel patent.

Claims 219 and 222 indirectly depend from claims 198 and 206, respectively. As discussed above, independent claims 198 and 206 are not obvious in view of the Lee patent in combination with the Weiss patent. The Korgel patent does not remedy the deficiencies of the Lee and Weiss patents. In particular, the Korgel patent discloses semiconductor nanoparticles that can be used in light emitting diodes. The Korgel patent does not disclose a concentration-gradient quantum dot, any generalized or specific method for preparing a concentration-gradient quantum dot, or any optical properties of a concentration-gradient quantum dot.

In view of the foregoing, the obviousness rejection of appealed claims 219 and 222 should be withdrawn.

Conclusion

For the foregoing reasons, Appellants respectfully request the reversal of the obviousness rejections of the subject patent application.

Respectfully submitted,

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Date: November 30, 2010

Claims Appendix

1.-197. (Cancelled)

198. (Previously Presented) A concentration-gradient quantum dot comprising an alloy of a first semiconductor and a second semiconductor, wherein the concentration of the first semiconductor gradually increases from the core of the quantum dot to the surface of the quantum dot and the concentration of the second semiconductor gradually decreases from the core of the quantum dot to the surface of the quantum dot, wherein the alloy comprises CdSeTe and has a molecular formula $CdSe_{1-x}Te_x$, the alloy comprises CdSSe and has a molecular formula $CdS_{1-x}Se_x$, the alloy comprises CdSTe and has a molecular formula $CdS_{1-x}Te_x$, the alloy comprises ZnSeTe and has a molecular formula $ZnSe_{1-x}Te_x$, the alloy comprises ZnCdTe and has a molecular formula $Zn_{1-x}Cd_xTe$, the alloy comprises CdHgS and has a molecular formula $Cd_{1-x}Hg_xS$, the alloy comprises HgCdTe and has a molecular formula HgCdTe, the alloy comprises InGaAs and has a molecular formula InGaAs, the alloy comprises GaAlAs and has a molecular formula GaAlAs, or the alloy comprises InGaN and has a molecular formula InGaN, wherein x is any fraction between 0 and 1, and wherein the concentration-gradient quantum dot has a band gap energy that is non-linearly related to the molar ratio of the at least two semiconductors.

199. (Previously Presented) The concentration-gradient quantum dot of claim 198, wherein the quantum dot has a quantum yield that is at least about 15%.

200.-202. (Cancelled)

203. (Previously Presented) The concentration-gradient quantum dot of claim 198, wherein the alloy comprises CdSeTe.

204. (Previously Presented) The concentration-gradient quantum dot of claim 198, wherein the quantum dot is conjugated to a biological agent.

205. (Previously Presented) The concentration-gradient quantum dot of claim 198, wherein the quantum dot is encapsulated within a polymer bead.

206. (Previously Presented) A series of concentration-gradient quantum dots,

wherein each quantum dot comprises an alloy of a first semiconductor and a second semiconductor,

wherein, for each quantum dot, the concentration of the first semiconductor gradually increases from the core of the quantum dot to the surface of the quantum dot and the concentration of the second semiconductor gradually decreases from the core of the quantum dot to the surface of the quantum dot,

wherein the gradient by which the concentration of the first semiconductor increases and the gradient by which the concentration of the second semiconductor decreases from the core of the quantum dot to the surface of the quantum dot varies among the quantum dots of the series,

wherein the size of each quantum dot is within about 5% of the size of the average-sized quantum dot,

wherein the alloy comprises CdSeTe and has a molecular formula $CdSe_{1-x}Te_x$, the alloy comprises CdSSe and has a molecular formula $CdS_{1-x}Se_x$, the alloy comprises CdSTe and has a molecular formula $CdS_{1-x}Te_x$, the alloy comprises ZnSeTe and has a molecular formula $ZnSe_{1-x}Te_x$, the alloy comprises ZnCdTe and has a molecular formula $Zn_{1-x}Cd_xTe$, the alloy comprises CdHgS and has a molecular formula $Cd_{1-x}Hg_xS$, the alloy comprises HgCdTe and has a molecular formula HgCdTe, the alloy comprises InGaAs and has a molecular formula InGaAs, the alloy comprises GaAlAs and has a molecular formula GaAlAs, or the alloy comprises InGaN and has a molecular formula InGaN, wherein x is any fraction between 0 and 1,

wherein each quantum dot comprises the same semiconductors, and

wherein each quantum dot of the series has a band gap energy that is non-linearly related to the molar ratio of the at least two semiconductors.

207. (Previously Presented) The series of concentration-gradient quantum dots of claim 206, wherein each of the quantum dots has a quantum yield that is at least about 15%.

208.-209. (Cancelled)

210. (Previously Presented) The series of concentration-gradient quantum dots of claim 206, wherein each of the quantum dots are conjugated to a biological agent.

211. (Previously Presented) The series of concentration-gradient quantum dots of claim 210, wherein each of the quantum dots is conjugated to a different biological agent, such that each of the different biological agents corresponds to a quantum dot having a unique gradient of the first semiconductor and second semiconductor.

212. (Previously Presented) The series of concentration-gradient quantum dots of claim 207, wherein each of the quantum dots is conjugated to a biological agent.

213. (Previously Presented) The series of concentration-gradient quantum dots of claim 206, wherein each of the quantum dots is encapsulated within a polymer bead.

214. (Previously Presented) A method of detecting a target in a sample, which method comprises:

(i) contacting a sample with the concentration-gradient quantum dot of claim 204, wherein the biological agent specifically binds to a target in the sample,

(ii) allowing the biological agent to specifically bind to the target, and

(iii) analyzing the sample via spectroscopy, thereby obtaining a spectroscopic signature of the sample, wherein the spectroscopic signature is indicative of the presence or the absence of the target in the sample.

215. (Previously Presented) A method of detecting more than one target in a sample, which method comprises:

(i) contacting a sample with the series of concentration-gradient quantum dots of claim 211, wherein each of the biological agents specifically bind to a different target in the sample,

(ii) allowing the biological agents to specifically bind to the targets,

(iii) analyzing the sample via spectroscopy, thereby obtaining a spectroscopic signature of the sample, wherein the spectroscopic signature is indicative of the presence or absence of the more than one target in the sample.

216. (Withdrawn) A method of producing a ternary concentration-gradient quantum dot comprising a first semiconductor AB and a second semiconductor AC, wherein A is a species that is common to the first semiconductor and the second semiconductor and B and C are each a species found in only one of the first semiconductor and the second semiconductor, which method comprises:

(i) providing a first solution under conditions which allow nanocrystal formation to take place,

(ii) providing a second solution comprising A, B, and C at a molar ratio under conditions which do not allow nanocrystal formation to take place, wherein each of B and C are present in the second solution at a concentration that is reaction-limiting,

(iii) adding the second solution to the first solution, thereby allowing nanocrystal formation to take place, and

(iv) changing the conditions to conditions that halt nanocrystal growth and formation.

217. (Withdrawn) A method of producing a series of ternary concentration-gradient quantum dots, wherein each of the quantum dots comprise a first semiconductor AB and a second semiconductor AC, wherein A is a species that is common to the first semiconductor and the second semiconductor and B and C are each a species found in only one of the first semiconductor and the second semiconductor, which method comprises:

(i) providing a first solution under conditions which allow nanocrystal formation to take place,

(ii) providing a second solution comprising A, B, and C at a molar ratio under conditions which do not allow nanocrystal formation to take place, wherein each of B and C are present in the second solution at a concentration that is reaction-limiting,

(iii) adding the second solution to the first solution, thereby allowing nanocrystal formation to take place,

(iv) changing the conditions to conditions that halt nanocrystal growth and formation, and

(v) repeating steps (i)-(iv) at least one time, thereby producing at least one other quantum dot of the series, wherein each time the molar ratio of A, B, and C is different from the molar ration of A, B, and C of the other quantum dots of the series.

218. (Previously Presented) An optoelectric device comprising the alloyed semiconductor quantum dot of claim 198.

219. (Previously Presented) The optoelectric device of claim 218, wherein the device is a light emitting diode or solar cell.

220. (Previously Presented) The optoelectric device of claim 218, wherein the quantum dot is used in lieu of the bulk semiconductor material.

221. (Previously Presented) An optoelectric device comprising the alloyed semiconductor quantum dot of claim 206.

222. (Previously Presented) The optoelectric device of claim 221, wherein the device is a light emitting diode or solar cell.

223. (Previously Presented) The optoelectric device of claim 221, wherein the quantum dot is used in lieu of the bulk semiconductor material.

224. (Previously Presented) The series of concentration-gradient quantum dots of claim 206, wherein the alloy comprises CdSeTe.

Evidence Appendix

Exhibit A: Copy of Declaration Under 37 C.F.R § 1.132 of Shuming Nie filed on October 1, 2009 and entered in the record by the Examiner on October 29, 2009.

Related Proceedings Appendix

Not Applicable.